crystallizing at least a surface layer of the thin film by supplying high energy through an introduction window that exhibits transparency to the energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallization is carried out ~~in~~ a high energy supply apparatus including a generation source for generating the high energy and a supply chamber for supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber has the introduction window provided in a portion of the wall of the supply chamber, for introducing the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm;

when a first position of the thin film is irradiated with the high energy introduced into the supply chamber, part of the high energy enters the thin film; and another part of the high energy is reflected by the thin film to form reflected energy that irradiates a second position of the thin film through a course change of the reflected energy.

REMARKS

Claims 1, 2, and 4-63 are pending. Claims 19, 24, 29, 34, 39, 44, 45 and 50-55 have been previously withdrawn from consideration. By this Amendment, claims 1, 12, 20, 25, 30, 35, 40, 46 and 56 are amended to recite that the hydrogen-containing atmosphere is of at least or approximate atmospheric pressure. Reconsideration based on the above amendments and following remarks is respectfully requested.

The attached Appendix includes marked-up copies of each rewritten claim (37 C.F.R. §1.121(c)(1)(ii)).

I. <u>The Claims Define Allowable Subject Matter</u>

The Office Action rejects claims 1, 2, 4-18, 21-23, 25-28, 30-33 and 35-38 under 35 U.S.C. §103(a) over U.S. Patent 5,329,207 to Cathey et al. and U.S. Patent 5,200,630 to

Nakamura et al.; and claims 40-43, 46-49 and 56-63 under 35 U.S.C. §103(a) over Cathey et al., Nakamura et al. and further in view of JP A 58-090722 to Sato. These rejections are respectfully traversed.

Cathey et al., does not teach, disclose or suggest "crystallizing at least a surface layer of the thin film by applying energy to a window that exhibits transparency to the energy to the surface of the thin film, wherein a distance between the window and the thin film is more than about twenty mm, and at least the surface layer of the thin film is melted by the applied energy and crystallized by cooling solidification under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure," as recited as recited in claim 1, and as similarly recited in claims 12, 20, 25, 30, 35, 40, 46 and 56.

Instead, Cathey et al. merely discloses that significant recent work has involved the use of laser beam recrystallization to convert polycrystalline or amorphous silicon regions to a monocrystalline form (col. 6, lines 22-29) and that the grain boundaries can be hydrogenated to improve mobility of the electrons within the substrate (col. 6, lines 56-58). Cathey et al. does not disclose or suggest any subject matter regarding having a window twenty millimeters apart from the thin film and having a hydrogen-containing atmosphere of at least or approximate atmospheric pressure.

Nakamura et al. does not make up for these deficiencies. Instead, Nakamura et al. discloses typical conditions for generating hydrogen plasma having a pressure of 0.1 through 1 Torr, which value is at least three orders of magnitude smaller in pressure than the claimed atmospheric pressure. Furthermore, Nakamura et al. does not disclose or suggest having a window distanced about 20 millimeters apart from the thin film.

Sato (JP A 58-090722) does not make up for these deficiencies. Instead, Sato merely discloses that the incident angle of a beam may be set according to the required shape, use and the characteristics of a semiconductor device.

For at least these reasons, the combination of Cathey et al. and Nakamura et al. does not render obvious the subject matter of claims 1, 2, 4-18, 21-23, 25-28, 30-33 and 35-38 under 35 U.S.C. §103(a); and the combination of Cathey et al., Nakamura et al. and Sato does not render obvious the subject matter of claims 40-43, 46-49 and 56-63 under 35 U.S.C. §103(a). Withdrawal of the rejections of claims 1, 2, 4-18, 21-23, 25-28, 30-33 and 35-38 under 35 U.S.C. §103(a) over Cathey et al. and Nakamura et al.; and claims 40-43, 46-49 and 56-63 under 35 U.S.C. §103(a) over Cathey et al., Nakamura et al. and further in view of Sato is respectfully requested.

II. Conclusion

For at least these reasons, it is respectfully submitted that this application is in condition for allowance. Reconsideration of the application is requested.

Should the Examiner believe anything further is desirable to place this application in even better condition for allowance the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

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JAO:RJK/mdw

Attachment:
Appendix

Date: December 12, 2002

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE
AUTHORIZATION
Please grant any extension
necessary for entry;
Charge any fee due to our
Deposit Account No. 15-0461

APPENDIX

Changes to Claims:

The following is a marked-up version of the amended claim(s):

1. (~~Five~~ Six Times Amended) A method of forming a crystalline film, comprising:

forming a thin film having a surface on a glass substrate; and

crystallizing at least a surface layer of the thin film by applying energy through a window that exhibits transparency to the energy to the surface of the thin film, wherein a distance between the window and the thin film is more than about 20 mm, and at least the surface layer of the thin film is melted by the applied energy and crystallized by cooling solidification under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure,

wherein unpaired bonding electrons on the surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure.

12. (~~Five~~ Six Times Amended) The method of forming a crystalline film, comprising:

forming a semiconductor thin film having a surface on a glass substrate; and

crystallizing at least a surface layer of the semiconductor thin film by applying energy through a window that exhibits transparency to the energy to the surface of the semiconductor thin film, wherein a distance between the window and the thin film is more than about 20 mm, and at least the surface layer of the semiconductor thin film is melted by the applied energy and crystallized by cooling solidification under an atmosphere of at least or approximate atmospheric pressure containing a gas containing the component element of the semiconductor thin film and hydrogen,

wherein unpaired bonding electrons on the surface of the semiconductor thin film during the cooling solidification are terminated by hydrogen atoms in the atmosphere of at least or approximate atmospheric pressure.

20. (~~Six~~ Seven Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate;

setting the thin film in a supply chamber of a high energy supply apparatus including a generation source for generating the high energy and the supply chamber for supplying the high energy to the thin film, the supply chamber including an introduction window that exhibits transparency to the energy and introduces the high energy into the supply chamber;

crystallizing at least a surface layer of the thin film by supplying high energy through the introduction window to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film being melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification being terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure; and

positioning the introduction window relative to the thin film at a location resistant to adherence of components of the thin film when the high energy is supplied to the thin film such that a distance between the introduction window and the thin film is more than about 20 mm.

25. (~~Six~~ Seven Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate;

setting the thin film in a supply chamber of a high energy supply apparatus including a generation source for generating the high energy and the supply chamber for supplying the high energy to the thin film, the supply chamber including a wall and an introduction window provided in a portion of the wall, the introduction window introducing the high energy into the chamber;

crystallizing at least a surface layer of the thin film by supplying high energy through the introduction window that exhibits transparency to the energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film being melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification being terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure; and

positioning the introduction window relative to the thin film so that a distance between the introduction window and the thin film is larger than about 20 mm.

30. (~~Five~~ Six Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a substrate; and

crystallizing at least a surface layer of the thin film by supplying high energy to the thin film under a hydrogen containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by

cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallizing is carried out in a high energy supply apparatus which includes a generation source for generating the high energy and a supply chamber for a supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber includes an introduction window that exhibits transparency to the energy and introduces the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm; and

the high energy is supplied to the thin film under a pressure in the vicinity of the introduction window that is higher than a pressure in the vicinity of the thin film in the supply chamber.

35. (~~Five~~ Six Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate; and

crystallizing at least a surface layer of the thin film by supplying high energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallizing is carried out in a high energy supply apparatus which includes a generation source for generating the high energy and supply chamber for supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber includes an introduction window that ~~that~~ exhibits transparency to the energy and introduces the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm, and an exhaust port for exhausting air in the supply chamber; and

the high energy is supplied to the thin film under (i) a pressure in the vicinity of the introduction window that is higher than a pressure in the vicinity of the thin film, and (ii) a pressure in the vicinity of the thin film that is higher than a pressure in a vicinity of the exhaust port in the supply chamber.

40. (~~Five~~ Six Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate;

crystallizing at least a surface layer of the thin film by supplying high energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallizing is carried out in a high energy supply apparatus which includes a generation source for generating the high energy and a supply chamber for supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber includes an introduction window that exhibits transparency to the energy and introduces the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm;

the thin film is irradiated with the high energy introduced into the supply chamber through the introduction window along an irradiation path in the supply chamber;

a part of the high energy enters the thin film, and another part of the high energy is reflected from the thin film along a reflection path in the supply chamber;

a gas flow is present in the supply chamber; and

the high energy is supplied to the thin film with (i) the gas flow from the introduction window to the thin film in approximately the same direction as the irradiation path, and (ii) the gas flow from the thin film in approximately the same direction as the reflection path.

46. (~~Six~~ Seven Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate; and

crystallizing at least a surface layer of the thin film by supplying high energy through an introduction window that exhibits transparency to the energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallization is carried out in a high energy supply apparatus that includes a generation source for generating the high energy and a supply chamber for supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber has the introduction window provided in a portion of the wall of the supply chamber, for introducing the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm;

the thin film is irradiated with the high energy introduced into the supply chamber through the introduction window, the high energy passes through the introduction window along an irradiation path and travels along the irradiation path in the supply chamber; and

the high energy is supplied to the thin film with the normal direction of the thin film shifted by an angle from the direction of the irradiation path.

56. (~~Five~~ Six Times Amended) A method of forming a crystalline film, comprising:

forming a thin film on a glass substrate; and

crystallizing at least a surface layer of the thin film by supplying high energy through an introduction window that exhibits transparency to the energy to the thin film under a hydrogen-containing atmosphere of at least or approximate atmospheric pressure, at least the surface layer of the thin film is melted by the high energy and crystallized by cooling solidification, and unpaired bonding electrons on a surface of the thin film during the cooling solidification are terminated by hydrogen atoms in the hydrogen-containing atmosphere of at least or approximate atmospheric pressure, wherein:

crystallization is carried out in a high energy supply apparatus including a generation source for generating the high energy and a supply chamber for supplying the high energy to the thin film;

the thin film is set in the supply chamber;

the supply chamber has the introduction window provided in a portion of the wall of the supply chamber, for introducing the high energy into the supply chamber, wherein a distance between the introduction window and the thin film is more than about 20 mm;

when a first position of the thin film is irradiated with the high energy introduced into the supply chamber, part of the high energy enters the thin film; and another part of the high energy is reflected by the thin film to form reflected energy that irradiates a second position of the thin film through a course change of the reflected energy.